Employing Risk Management to Control Military Construction Costs

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Agenda

- Research Purpose
- Literature Review
- Methodology
- Results
- Conclusions
- Areas for Further Research

Research Purpose

- The research sought to define how risk management was conducted on a Military Construction (MILCON) project – the NCE Program.

- Confirm whether employing risk management techniques on military construction projects allowed the program management team to be more effective in regards to achieving the project's cost, schedule or performance objectives.

Literature Review Highlights

Risk Management on Construction Projects:

- The construction industry focuses almost exclusively on financial risk [to themselves] (Baker, Ponniah & Smith, 1999).
- A possible explanation for the relatively low use of risk analysis is the concern in both the literature and the business community as to its real 'bottom-line' benefit (Burchett, Tummala & Leung, 1999).
- DoD guidance only addresses risk management in the context of major weapon systems (Bolles, 2003).
- Risk Management Plans will be developed as a component of an overarching PMP to allow for the continuous monitoring of risks on MILCON projects (USACE, ER 1110-1-12, 2006).
- Mr. Joe Tyler's observation that MILCON projects completed by USACE prior to FY2006 did not employ risk management processes as were practiced on the NCE Program (Tyler, 2009).
- Numerous studies have shown that only a relatively small number of risk techniques are used due to a lack of knowledge (Forbes, Smith & Horner, 2008).
- In practice, risk management ends before construction begins (Khadka & Bolyard, 2009)

Research Methodology

Statement of Problem:

- Investigate whether program managers employing risk management techniques on military construction projects were more effective than those who did not.

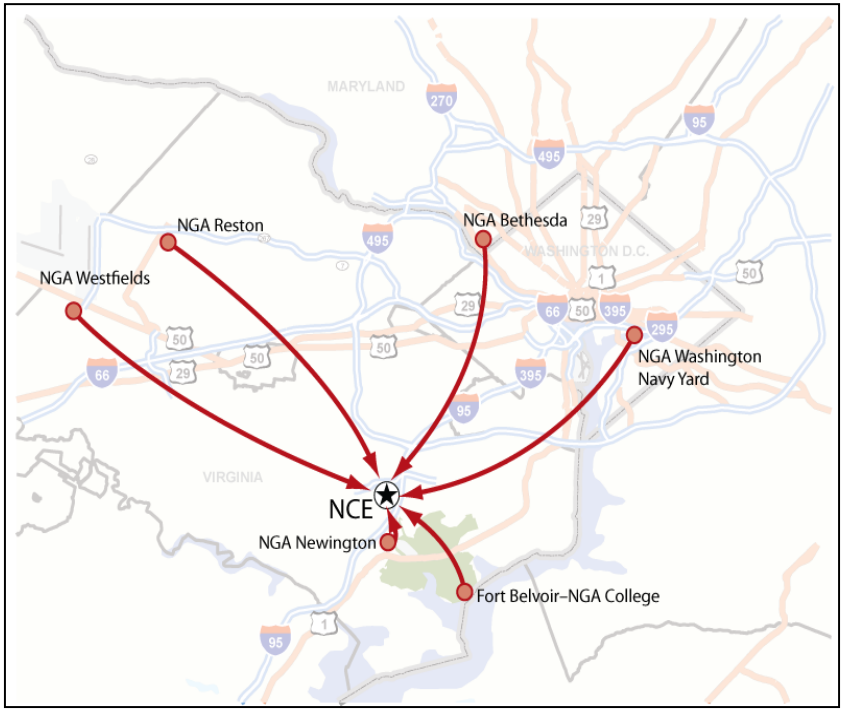
- Level of effectiveness was assessed by measuring the cost growth realized on military construction projects.

Research Methodology

- Hypothesis.
  - H_0: $\mu_{\text{Historical MILCON}} = \mu_{\text{NCE Program}}$
  - H_1: $\mu_{\text{Historical MILCON}} > \mu_{\text{NCE Program}}$
- Variables:
  - Independent: Use of Risk Management techniques during construction.
  - Dependent: Cost Growth realized.
- Methodology:
  - Case Study of the NCE Program
  - Historical Research (USACE database)
- Data Analysis Method:
  - A t-test for independent means will be used to test this hypothesis
  - α value of 0.05

Results – NCE Case Study

BRAC Consolidation



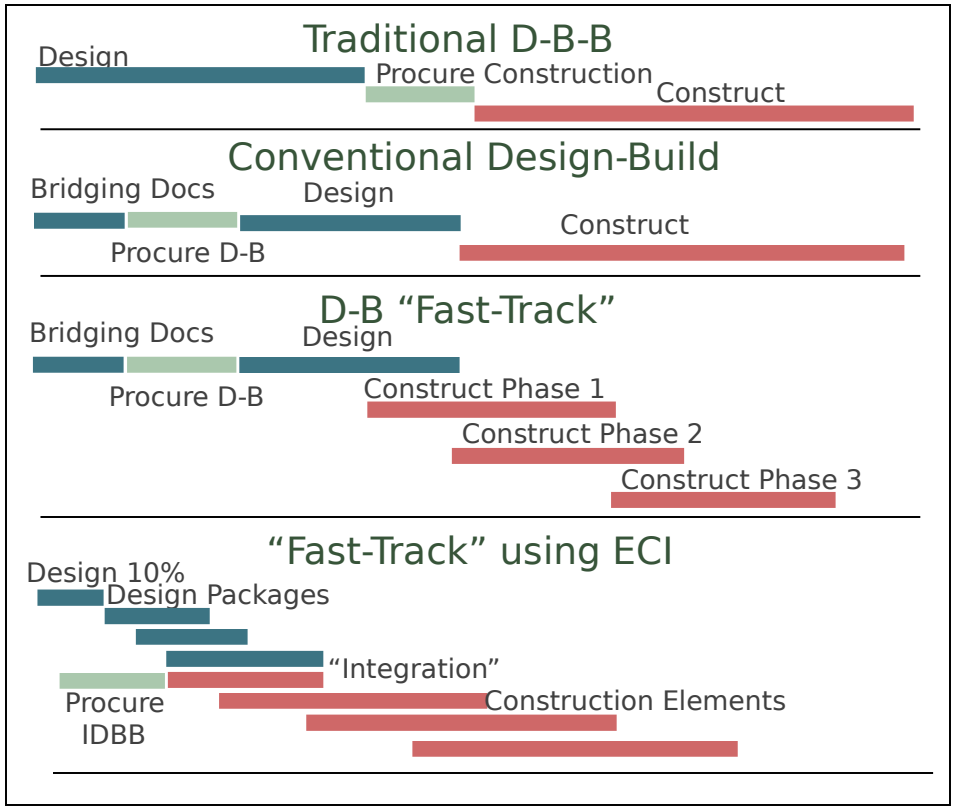
Program Scope

NCE Case Study - Differences

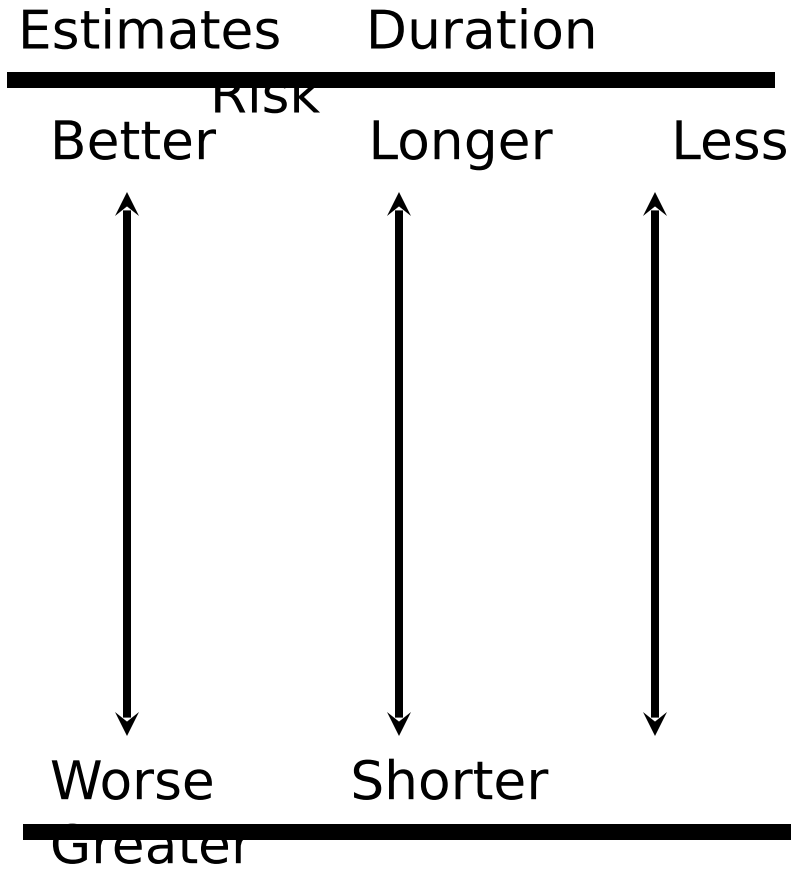
Beyond enormity and a “hard” completion date:

- Delivery Method – Early Contractor Involvement
- Governance Structure – integrated, multi-level
- Risk Management – throughout execution

NCE Case Study – Delivery Method



Considerations:



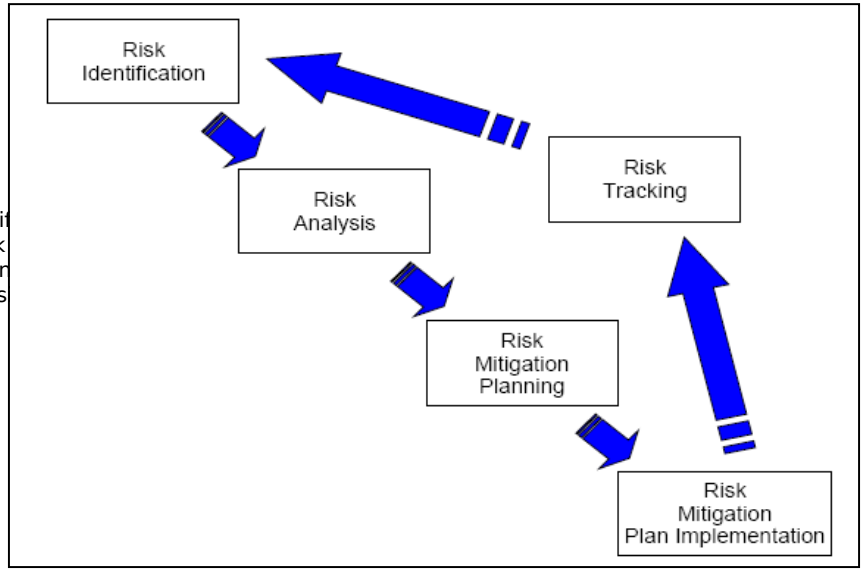
NCE: ECI Delivery w/ Fixed Price - Successive Targets

NCE Case Study – Governance

- ✓ Hierarchical
- ✓ Integrated Membership
- ✓ Integrated Rhythm
- ✓ Project Focused

NCE Case Study – Risk Management

- Implemented per *Risk Management Guide for DOD Acquisition* (2006)



- Full time staff (~1.5 FTEs)
- Conducted throughout Program's lif
- Cross-Program participation in Risk
- Reporting integrated with governan
- PLTs empowered with defined decis

NCE Case Study – Risk Management

The George Washington University
WASHINGTON DC

Probability-Impact Matrix		Impact				
		Negligible	Marginal	Significant	Critical	Catastrophic
Cost	Probability	No Impact To NCE Cost Baseline	Less than $1M	Between $1M and $10M	Between $10M and $100M	Greater than $100M
	Near Certain (80-99%)	5	12	19	22	25
	Highly Likely (60-79%)	4	11	18	21	24
	Likely (40-59%)	3	10	14	20	23
	Unlikely (20-39%)	2	7	13	15	17
	Remote (1-19%)	1	6	8	9	16
Schedule	Probability	No Impact To NCE IMS Milestones	Does not impact Critical Path or Anchor Point	Impacts Critical Path and results in slip to one Anchor Point	Impacts Critical Path and results in slip to more than one Anchor Point. BRAC date is still met.	Impacts Critical Path and results in slip to more than one Anchor Point. BRAC date is not met.
	Near Certain (80-99%)	5	12	19	22	25
	Highly Likely (60-79%)	4	11	18	21	24
	Likely (40-59%)	3	10	14	20	23
	Unlikely (20-39%)	2	7	13	15	17
	Remote (1-19%)	1	6	8	9	16
Performance	Probability	No Impact	Performance impacts can be contained within WBS	Performance impacts contained within PMO	Performance impacts results in realignment of NCE priorities	Performance impacts entire Enterprise, Externals, or Oversight Agencies
	Near Certain (80-99%)	5	12	19	22	25
	Highly Likely (60-79%)	4	11	18	21	24
	Likely (40-59%)	3	10	14	20	23
	Unlikely (20-39%)	2	7	13	15	17
	Remote (1-19%)	1	6	8	9	16

NCE Case Study – Risk Management

Risk Statement

- **IF**
- **THEN**

Decision / Trigger Points (Key Dates or Events)

-

Closure Criteria

-

Risk Score with Analysis:

Probability:
Cost Impact:
Schedule Impact:
Performance Impact:

Probability Key: Issue (100%); Near Certain (80-99%); Highly Likely (60-79%); Likely (40-59%); Unlikely (20-39%); Remote (1-19%)

Impact Key: Catastrophic; Critical; Significant; Marginal; Negligible

Mitigation Plan

Step	Date	Action	Target Score	Status
1				
2				
3				
4				

Context

-
-
-

Status / Sticking Point

NCE: Over 150 Risks tracked above the PLT level

Results – USACE Data

Descriptive Statistics – Baseline Value

N	Mean	Min	Max
53	$11,219,270	$1,358,000	$41,583,019

Descriptive Statistics – Final Value

N	Mean	Min	Max
53	$12,209,099	$1,378,202	$44,829,071

Descriptive Statistics – Cost Growth

N	Mean	Std Dev	Min	Median	Max
53	7.49	9.73	-7.27	4.96	57.65

Results – NCE Data

NCE Facility Project	Baseline Contract Value (Base + Options)	Cost Growth Amount	Final Contract Amount	Cost Growth (%)
CUP	$99,961,243	$7,503,144	$107,464,387	7.51
TC	$77,996,108	($5,645,069)	$72,351,039	(7.24)
Garage	$76,729,943	($4,443,661)	$72,286,282	(5.79)
VCC	$5,880,734	$79,397	$5,960,131	1.35

Descriptive Statistics – Cost Growth

N	Mean	Std Dev	Min	Median	Max
4	-1.04	6.83	-7.24	-2.22	7.51

Results - Data Analysis

Raw Analysis:

- USACE Historical Sample Mean Cost Growth (7.49%) is greater than (>) that of the NCE Sample (-1.04%).
- Had the NCE Sample experienced the mean cost growth of USACE's Historical Sample – additional $22,234,270 cost.
- Noteworthy, but statistically significant?

t-Test for Independent Means:

Null Hypothesis	Alternative Hypothesis	Rejection Criterion
$\mathbf{H_0 : \mu_{Hist} = \mu_{NCE}}$	$\mathbf{H_1 : \mu_{Hist} > \mu_{NCE}}$	$\mathbf{t_0 > t_{\alpha, v}}$

Results - Data Analysis

Conditions for a t-test of sample means:

- ✓ Samples are independent
- ✓ Samples approximate a normal distribution
- ✓ Variances are approximately equal

Step 1: Calculate pooled standard deviation.

$$s_p = \sqrt{\frac{(n_1 - 1) \times s_1^2 + (n_2 - 1) \times s_2^2}{(n_1 - 1) + (n_2 - 1)}}$$

Step 2: Calculate the *t* statisti

$$t_0 = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Step 3: Calculate degrees of freedom.

$$\nu = (n_1 - 1) + (n_2 - 1)$$

Results - Data Analysis

Historical MILCON Sample:

- $n_1 = 53$ projects, x-bar$_{HIST} = 7.49$, $S_{HIST} = 9.73$

NCE Sample:

- $n_2 = 4$ projects, x-bar$_{NCE} = -1.04$, $S_{NCE} = 6.83$

$$s_p = \sqrt{\frac{(n_1 - 1) \times s_1^2 + (n_2 - 1) \times s_2^2}{(n_1 - 1) + (n_2 - 1)}} \quad = 9.5944$$

$$t_0 = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad = 1.7145 \qquad \nu = (n_1 - 1) + (n_2 - 1) \quad = 55$$

$t_0 = 1.7145 > t_{0.05, 55} = 1.673 \Rightarrow$ Reject H_0

Results - Data Analysis

MiniTab verification:

Two-Sample T-Test and CI: USACE, NCE

Two-sample T for USACE vs NCE

	N	Mean	StDev	SE Mean
USACE	53	7.49	9.73	1.3
NCE	4	-1.04	6.83	3.4

Difference = mu (USACE) - mu (NCE)

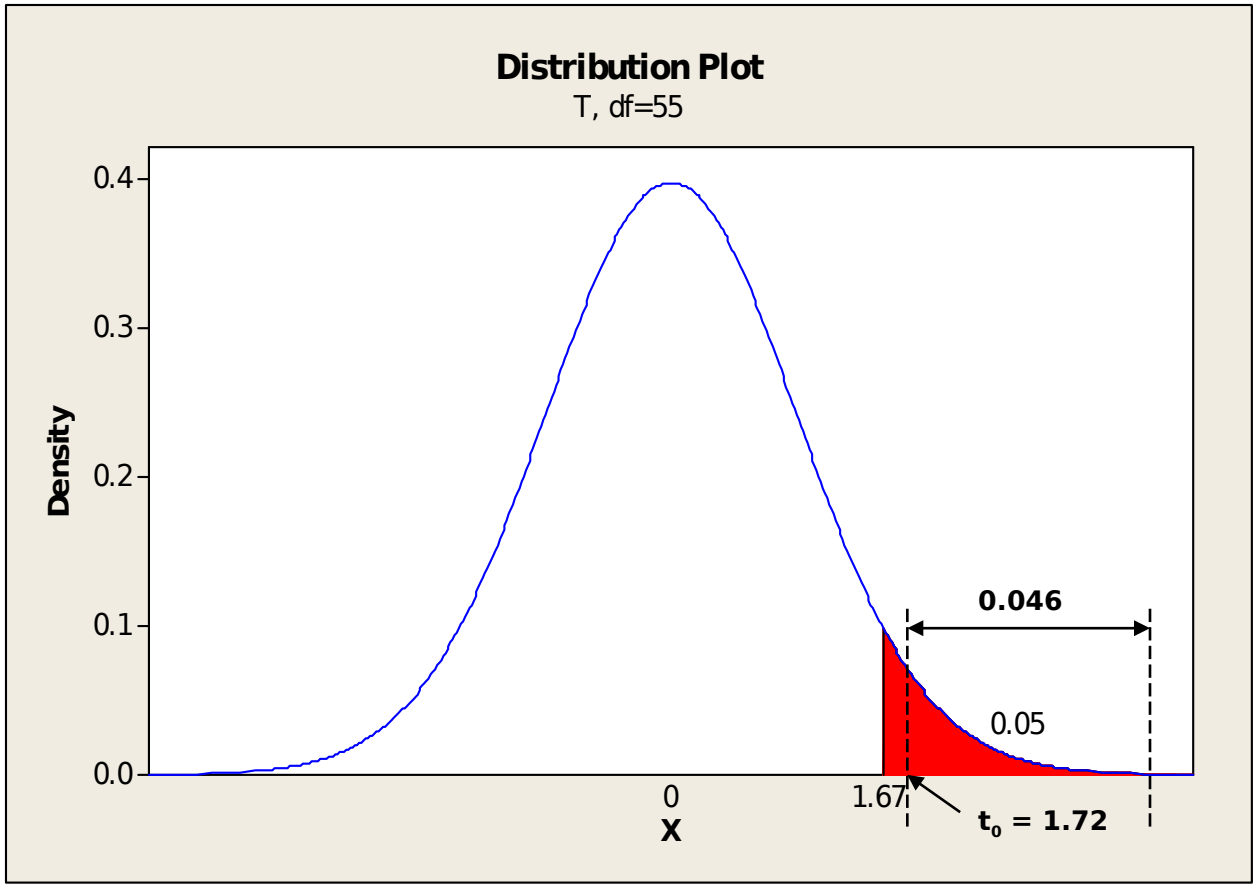
Estimate for difference: 8.54

95% lower bound for difference: 0.21

T-Test of difference = 0 (vs >): T-Value = 1.72 P-Value = 0.046 DF = 55

Both use Pooled StDev = 9.5931

Results - Data Analysis



$t_0 = 1.72 > t_{0.05, 55} = 1.67 \Rightarrow$ Reject H_0

Conclusions

- t_o lies in the critical zone.
- Reject the null hypothesis.
- There is sufficient evidence to support the claim that MILCON projects that employ risk management processes as practiced on the NCE Program experience less cost growth on average than those that do not.
- Significance of research:
  - Adds to the body of knowledge for not only risk management practices on military construction projects but on construction projects in general.
  - Describes in detail a risk management program employed during the construction phase of a project.
  - Proves that employing risk management

Questions, Comments or Suggestions?

Backup Slides

Literature Review Gaps

- From Edwards & Bowen's review (1998):
  - Methods by which risks identified and analyzed before the start of a project could be continually reassessed during the project's delivery phase.
  - Setting goals for the Risk Management effort.
  - Processes by which risk could be communicated between project partners (owner-designer-constructor-user).
- Post-1997 gaps:
  - Description and implementation of risk management in a DoD/PMI context.
  - Establishing the value of performing risk management during the construction phase.

Literature Review Gaps

Project Development	RFP & Award	Construction	Turnover & Use
• Scope (Design) • Budget • Delivery Method	• Bid Prep • Negotiations • Contract Award	• Cost • Schedule • Performance • Worker Safety	• Operations • Maintenance

Risk Extends Throughout Project's Lifecycle

Considerations:

✓ Project Reserve ✓ Contract Type ✓ Profit Estimation	✓ Bid Contingency ✓ Liquidated Damages Rate ✓ Bonding ✓ Project	✓ Worker Safety ~ Cost ~ Schedule ~ Performance	✓ Design Deficiency ✓ Warranties

Research Methodology

Data Collection:

- Cost growth of all USACE-administered MILCON projects completed in the continental US during FYs 04-05. Source: USACE's Program Mgmt Info System (P2).

- Cost growth realized on four (4) of the sub-projects comprising NGA's New Campus East Program that had achieved substantial completions:
  - Central Utility Plant
  - Technology Center
  - Parking Structure
  - Visitor Control Center

Areas for Further Research

- Appropriateness of risk management as a technique for controlling a project's schedule (or time growth).
- Whether the selected acquisition strategy (delivery method) influences the effectiveness and value of risk management processes.
- Whether the selected contract type influences the effectiveness and value of risk management processes.
- Whether break-even points can be forecasted below which formalized risk management processes and dedicated staff would not be suggested.